Please do not cite this paper

OECD Review of Innovation in Southeast Asia

Country Profile of Innovation: Thailand

This paper is part of a series of preliminary drafts for the *OECD Review of Innovation in Southeast Asia* provided by the OECD Secretariat. It is provided for the purpose of discussion at the SEA-EU-NET Chiang Mai Event (30 May – 1 June 2011) and for written comments by the relevant national authorities. Comments – referring, if applicable, to the respective paragraph number(s) – should be provided by e-mail as soon as possible but *no later than 30 June 2011* to the contacts given below.

This draft prepared by the OECD Secretariat will be used in Part 2 of the report of the *OECD Review of Innovation in Southeast Asia* which consists of *Country Profiles*. It draws upon a country background note prepared by Patarapong Intarakumnerd (College of Innovation, Thammasat University). Full acknowledgements will be provided in the published report.

Contacts:

Gernot.HUTSCHENREITER@oecd.org; Michael.KEENAN@oecd.org.

OECD Directorate for Science, Technology and Industry

COUNTRY PROFILE OF INNOVATION: THAILAND

PRELIMINARY DRAFT

Summary

1. Thailand has joined the ranks of middle-income countries, but further growth will have to come from innovation and efficiency improvements within the manufacturing and services sectors. Since the 1980s, economic performance has depended on foreign investment and exports. Thailand has become a key production base for global automotive and electronics firms from Japan, the United States and Europe. The agricultural sector employs almost 50% of workers as Thailand continues to be one of the world's largest rice exporters. Services carry great potential for growth, but tourism has been threatened by political instability. Thailand lags behind other countries in the region on most competitiveness indicators, including productivity and innovation.

2. The government has adopted a dual track policy to enhance the capabilities of Thai firms while increasing international competitiveness through expanding foreign investment, exports and tourism. The cluster concept which focuses on specific sectors, namely automobiles, food, fashion and software, became the main industrial and innovation policy. Numerous programs to encourage R&D and technology development have had limited outcomes. Thailand has derived few benefits from multinational firms, who primarily transfer technology embodied in equipment. Levels of R&D spending, S&T workers and patents are below those of Thailand's principal competitors.

3. Thailand can boost performance in the long-term by improving the skill level of the labor force, investing in ICT infrastructure, and coordinating and implementing S&T policies in a more effective manner. Upgrading the country's innovative capabilities depends on enhancing the quality of teaching and research at Thai universities, investing in targeted public research facilities, and providing incentives to R&D by foreign and local firms. To move beyond labor-intensive parts production and assembly, incentives are needed for firms in Thailand's manufacturing sector to strengthen collaborative linkages.

SWOT THAILAND

Strengths	Weaknesses
• Strong electronics and automotive sectors based on multinational firms • Large regional export markets, particularly China • Productive agricultural sector • Growing food processing industry • Expanding Thai creative industries	• Inadequate supply of skilled personnel • Low R&D investments • Lack of ICT and Internet services • Weak links between foreign and local firms • Ineffective industrial clusters policy • Disjointed S&T governance
Opportunities	**Threats**
• MNEs investing in local R&D including eco-cars • Market niches in Thai food and crafts • Growing tourist destination • S&T and industrial parks	• Competition from Asian countries for FDI • Lack of competition in many sectors • Political instability • Increasing brain drain

1. Macroeconomic performance and framework conditions

1.1. Performance and structure of the economy

4. Thailand is the 2nd largest economy in Southeast Asia after Indonesia and has advanced to the status of a middle-income country. After the Asian financial crisis of 1997, Thailand experienced a significant slowdown in economic growth which averaged under 4% per year in 2001-2009. The country was further hit by the global economic crisis which caused growth in gross domestic product (GDP) to fall to 2.8% in 2008. A resurgence of economic activity led to 7.5% growth in 2010, but predictions are for a decline to 3.2% in 2011. The 11th Economic and Social Development Plan (2012-2016) has a focus on creating a knowledge economy and sustainable society.

5. Thailand's growth has been driven by increasing foreign investment and resource reallocation between the sectors of the economy. Improvements in total factor productivity (TFP) have stemmed largely from the reallocation of labor and capital inputs from the agricultural sector to manufacturing and services. However, productivity growth in the manufacturing sector has been low and foreign technology spillovers embodied in international trade and investment have played a limited role. Weak productivity growth in services is linked to the lack of competition in the sector.

6. Beginning in the 1980s, Thailand's economy was built on open foreign investment policies and encouragement of the private sector. Manufacturing-led economic growth averaged 7.5% per year in the quarter century that preceded the Asian financial crisis based on abundant and inexpensive labor and natural resources. However, output fell sharply in 1997-1998 leaving millions of people unemployed. Thailand sought to regain economic momentum in 2001 by embracing a "dual track" economic policy that combined increased domestic activity with traditional promotion of open markets and foreign investment.

7. Thailand has markedly decreased poverty levels in the past quarter century although the poverty incidence remains high in the northern provinces. Vulnerable households suffered from the global economic crisis through a decline in agricultural prices and softer labor markets with poverty lines increasing by over 9% in 2008. There is a higher rate of poverty among the elderly who work primarily in agriculture and will represent over 17% of the population by 2020. Safety nets can help ensure that the benefits of high growth are shared more equally across the population. The Thai government has an ambitious plan to double the household income of the poor in nearly 3000 villages by 2012. Further land reforms, addressing political and economic elitism and corruption, and steps to ensure the more equitable distribution of wealth in Thailand are needed as a foundation for growth.

8. Thailand's development has been accompanied by sizeable changes in the structure of the economy. The country has significantly diversified from being a major rice exporter to a main production hub of multinational corporations in the automotive and electronic industries. The share of GDP accounted for by industry has more than doubled from 21% in 1970 to 42% today, while the share coming from the agricultural sector fell from 23% to 11% with services accounting for the remaining 47%.

9. Thailand's recovery from the 1997 Asian financial crisis depended mainly on increasing exports which now account for more than two-thirds of GDP. Since the 1970s, the share of primary products in exports fell by 70% while that of electronics, automotive and other manufactures increased by 57%. China became Thailand's largest export destination in 2010 replacing the United States. Thai export growth and economic recovery since 2008 have been driven primarily by demand from Thailand's regional trading partners. In 2010, export values in terms of US dollars surged by over 40% mainly in motor vehicles and parts, electronics and electrical appliances.

10. The electronics industry is the largest exporter in Thailand with hard disk drives contributing 32% of the total production value of the sector. Most firms are original equipment manufacturers (OEMs) for multinational enterprises. In 2006, Thailand was first in world rankings of hard disk drive exporters with 48% of global market share. However, the domestic value-added of the industry remains low at 31%. Another main export is automobiles and automotive parts which account for 12% of GDP. Rather than developing indigenous brands, Thailand is a key production base for global automotive firms from Japan, the United States and Europe. It ranks 13th among the motor vehicle producing countries in the world, and it is predicted that Thailand will be one of the top 10 producers in the world by 2015.

11. About 49% of Thailand's labor force is still employed in agriculture although this portion has decreased from 70% in 1980. The agricultural sector has experienced a transition from labor intensive and traditional methods to more modern production techniques. Rice remains the country's most important crop as Thailand is among the top exporters in the world rice market. Other agricultural commodities produced in significant amounts include fish and fishery products, tapioca, rubber, grain and sugar. Exports of processed foods such as canned tuna, pineapple and frozen shrimp are on the rise.

12. Thailand’s service sector is also growing, particularly tourism whose revenues contribute about 6% of GDP. European tourists comprise the largest percentage of visitors from high-income countries. Although Thailand experienced a decrease in foreign tourists in 2009, estimates have been revised upwards for 2010 and beyond. This is due to the easing of the global financial crisis, the vigorous growth of the Chinese economy, the relatively stable political situation following the 2008-2009 Thai political crisis, and the 2009 flu pandemic having less of an impact than initially feared. Thailand remains a competitive tourist destination and the recovery in consumer spending in advanced economies will continue to drive growth in this sector.

13. The economy is dominated by large multinationals, primarily Japanese, and large state-owned domestic firms which are the primary contributors to GDP. Thailand has a sizeable number of small and medium-sized enterprises (SMEs) which account for 78% of employment, 43% of non-agricultural GDP, and 30% of exports. Thailand’s medium-sized enterprises account for a much smaller proportion of the SME population than in other Asian countries indicating barriers to growth.

14. Thailand’s economic performance, which is based on a manufacturing-for-exports model, has lagged behind competitors in the Southeast Asian region. In 2010, Thailand ranked 38th out of 139 countries on the World Economic Forum Global Competitiveness Index and 26th out of 55 countries in the IMD World Competitiveness Rankings. Thailand’s economic success is most directly threatened by competition in labor-intensive manufactured goods from countries such as India, China, Vietnam and Indonesia. In order to compete in international markets, the country must move to higher value-added activities while attracting continued foreign investment, increasing exports, and improving the capabilities of domestic firms.

1.2. Framework conditions for innovation

15. Further increases in productivity and efficiency of resource use which have underlain economic growth in Thailand are now less important than investments in education, infrastructure, and entrepreneurs. Thailand's growing shortage of engineers and skilled technical personnel will limit future productivity growth. Secondary and tertiary education systems in Thailand are not ranked highly and there are serious deficiencies in the training of workers in the private sector. Thailand has a substantial Diaspora of skilled workers in other countries, but they have not been a source of local entrepreneurship or technical contributions.

16. Infrastructure such as telecommunications, transport and electricity generation have shown increasing strain during the period of sustained economic growth. Thailand has not invested sufficiently in telecommunications infrastructure, and levels of broadband penetration and rates of Internet use by business are behind those of other countries in the region (Table 1.1). Key challenges appear to be institutional as well as technological. Legislation governing radio spectrum licensing in Thailand originally envisaged that ICT decisions would be made jointly by the National Telecommunications Commission (NTC) and the National Broadcasting Commission (NBC) but internal disagreements over relative authority have slowed investments.

Table 1.1. Internet penetration rate per 100 population, Thailand and selected Southeast Asian countries

	1998	1999	2000	2001	2002	2003	2004	2005	2006
Cambodia	0.02	0.03	0.05	0.07	0.22	0.25	0.28	0.31	0.46
Indonesia	0.25	0.44	0.92	2.01	2.12	3.76	2.53	3.54	4.69
Malaysia	6.9	12.83	21.39	26.55	31.97	34.5	41.58	48.22	54.23
Philippines	1.13	1.46	2.01	2.56	4.4	4.93	5.32	5.48	5.92
Singapore	19.12	24.05	32.36	41.15	50.44	51.19	57.87	57.45	59.36
Thailand	***0.83***	***2.14***	***3.74***	***5.7***	***7.67***	***9.55***	***10.95***	***11.34***	***13.07***
Viet Nam	0.01	0.13	0.25	1.27	1.85	3.78	7.63	12.72	17.21

Source: UNESCO Statistical Unit, 2010.

17. The current ICT master plan (2009-2013) aims to strengthen ICT governance as well as ICT professionals and infrastructure. The Software Industry Promotion Agency (SIPA) was created in 2003 to support the small software industry and increase the information literacy of the Thai population. SIPA is currently cooperating with the Japan Industrial Promotion Agency and the Japanese Software Association to upgrade Thai programming resources and capabilities.

18. Barriers to entrepreneurship and the creation of innovative small firms persist. The large number of SMEs in Thailand is mainly due to a lack of alternative job opportunities and deep labor market segmentation. The distribution of SMEs is very unequal across regions with about two-fifths located in the more prosperous Bangkok region, where only one tenth of the population lives. Most are not linked to the community of multinational enterprises or integrated into global supply chains. There are large developmental gaps between SMEs operating in the center of the country compared to those in the regions. The creation of innovative SMEs is hindered by inadequate education and training systems and limited access to financing.

19. Thailand's financial system supporting industrial development is bank-based, but the commercial banks which finance most private sector investment are reluctant to lend to risky start-ups. Industrial development banks set up by the government – the Industrial Finance Corporation of Thailand (IFCT), the SME Bank, and the Small Industry Credit Guarantee Corporation (SICGC) – have been ineffective in providing venture finance due to overly bureaucratic procedures. Application processes are complicated and time-consuming, causing SMEs to seek loans from informal sources where they can get credit more quickly. In addition, the maximum loan limit of the financial institutions is low and interest rates do not differ significantly from those of the commercial banks.

20. The Thai Venture Capital Association (TVCA), which was set up in 1994, is composed 50% of domestic and international private equity management firms, while the other half of members operate businesses giving financial, accounting and legal advice. However, the venture capital market remains stunted in Thailand, where funds primarily finance firms at the expansion or mezzanine stage rather than early start-ups. The government has provided funding for the SME Venture Capital Fund, the Thailand

Equity Fund, and the Thailand Recovery Fund and is considering tax incentives to promote more venture capital investment in Thailand.

21. The Market for Alternative Investment (MAI), which is a business unit of the Stock Exchange of Thailand (SET), was established in 1999 as a secondary market for trading SME shares. Although MAI requirements for initial public offering have been adjusted to promote SME entry, most small firms are disqualified for being below the minimum capitalization level. In addition, the founding shareholders in family-controlled SMEs are reluctant to enact common stock issues that would dilute levels of ownership. The capacity of the MAI as a conduit for small business in limited, particularly in promoting knowledge-intensive start-ups.

2. Innovation performance

22. Thailand has one of the lowest levels of research and development (R&D) spending and R&D workers in the region, and it continues to fall behind its income group. Thailand's domestic expenditure on research is about 0.25% of GDP, significantly less than Singapore, Malaysia and even Vietnam (Table 2.1). Thailand has a much lower share of R&D financed by the private sector than other middle-income countries in the region, with just over 40% contributed by industry, mostly the large multinationals, compared to over 50% in Malaysia and the Philippines. Public and private tertiary institutions and government research institutes account for 35% and 23% of R&D expenditures, respectively. The government now has a target of increasing R&D spending to at least 0.30% of GDP.

23. Innovation surveys find that only 6% of indigenous firms invest in R&D, primarily to improve production processes rather than to engage in product innovation. Thai firms in the automotive, electronics, and food processing industries focus on labor intensive and lower technology areas and rely more on labor cost advantages and lower overheads to compete in the Southeast Asian region. Few firms are attempting to move up the value chain by investing in R&D to stimulate innovation and enhance their technological capability.

24. Partly as a result of low R&D intensity, Thailand has the lowest patents per capita ratio in the region, about half that of Malaysia. About 75% of the patents issued by the Thai Department of Intellectual Property (DIP) are to foreign firms. In terms of patents registered at the US Patent Office, Thailand lags behind Singapore, Malaysia and the Philippines (Table 2.3). In the electronics sector, Thai firms which are second or lower tier suppliers do not produce patented products or processes and less than 1% of patents are awarded to Thai nationals, mostly in universities. In the automotive sector, most patents are awarded to Japanese carmakers and their subsidiaries. About 12% of automotive patents have been awarded to Thai nationals in recent years mostly for non-functional accessories. Consumer goods and equipment, food processing, medical technology, and chemical engineering are the main subjects of domestic patents granted.

25. Thailand performs better in terms of scientific publications with articles growing over 300% in the past ten years, just behind Singapore (Table 2.4), but the impact of Thai scientific publications is still relatively low (Table 2.5). About 56% of scientific articles published by Thai nationals have international co-authorship – with the United States (34%), Japan (23%) and England (12%) -- indicating some integration into international research networks. The highest share of scientific papers published in Thailand is in the agricultural sciences. Thailand ranks 63rd behind Malaysia and Singapore on the World Bank's Knowledge Economy Index (KEI) based on scores on education and innovation (Table 2.2). When controlling for GDP per capita, Thailand's rank on the innovation sub-index, which focuses on outcomes such as royalty payments, patents and journal publications, is at similar levels as China although it trails Malaysia.

Table 2.1. Thailand's R&D Performance from a Southeast Asian Comparative Perspective: Selected R&D Indicators

Country	Years	Population 2009 (000,000)	GDP per capita 2008 ($000s)	Total researchers FTE	Researchers per million	% women researcher (estimated 2009)	Female prof & tech. worker % total 2009#	Technicians per million	GERD as % of GDP	GERD per Capita PPP$	% GERD by business sector	GERD by business sector source of funds
Thailand	***2001***			***17,710***	***281***			***113***	***0.26 (2007)***	***13.5 (2006)***	***39.2 (2006)***	***(2002) 36.8***
	2005	***63.4***	***8.0***	***20,506***	***311***	***50.3***	***53***	***160***	***0.25***	***18.1***	***40.9***	***48.7***
Cambodia	2002	14.8	2.0	223 w	17 w	20.7	41	13 w	0.05 w	0.5 w	12.1 w	0
Indonesia	2000			44,984	219			*	.07 a	1.6 a	26.3 a	25.7 a
	2005	231.4	4.1	35,564 h	162 h	30.6	48	*	.05 a b	1.6 a b	3.7 a b	*
Malaysia	2000			6,423	276			40	0.49	44.9	57.9	(2002) 51.5
	2006	28.3	13.6	9,694	372	37.7	41	44	0.64	79.9	84.9	84.7
Philippines	2003			5,860	71			11	0.15	3.6	67.8	68.6
	2005	92.2	3.5	6,896	81	52.0	63	10	0.12	3.4	68	62.6
Singapore	2000			16,663	4,139			338	1.88	631.7	62	55
	2007	5.0	49.5	27,301	6,088	27.7	45	529	2.61	1,341.80	66.8	59.8
Vietnam	2002	85.8	2.9	9,328	115	42.8	51	*	0.19	3.1	14.5	18.1

a = partial data: b= break in series; h = head count not FTE; w = national estimation.

* Australia women researchers derived from 2006 census data.

Calculated from UNDP Human Development Report, 2009.

Source: UNESCO Statistical Unit, 2010.

Table 2.2. Knowledge Economy Index and Knowledge Index: Thailand v.s. Selected SEA Countries

Position in World Rank 145 countries (KEI)	Change in Rank from 1995	Country	Some Missing Data	KEI#	KI*	Economic Incentive Regime	Innovation	Education	ICT
19	+2	**Singapore**		8.44	8.03	9.68	9.58	5.29	9.22
48	-	**Malaysia**		6.07	6.06	6.11	6.82	4.21	7.14
63	***-9***	***Thailand***		***5.52***	***5.66***	***5.12***	***5.76***	***5.58***	***5.64***
89	-16	**Philippines**		4.12	4.03	4.37	3.8	4.69	3.6
103	-2	**Indonesia**		3.29	3.17	3.66	3.19	3.59	2.72
106	+14	**Vietnam**	X	3.51	3.74	2.79	2.72	3.66	4.85
137	-8	**Cambodia**		1.56	1.54	1.63	2.07	1.93	0.62

Knowledge economy Index (KEI) is calculated based on the average of the normalised scores of a country on all four pillars related to the knowledge economy: economic incentive and institutional regime; education; innovation; and ICT.

* The Knowledge Index (KI) measures a country's ability to generate. Adopt and use knowledge. The index is based on key variables in the three knowledge pillars: education; innovation; and ICT.

Source: World Bank, http://info.worldbank.org/etools/kam2/KAM_page5.asp?tid=0&year=2002&sortby=KEI&sortorder=DESC&weighted=Y&cid1=27

Table 2.3. USPTO Patents Granted to Selected SEA Countries, 2000-2007

Country	2000	2001	2002	2003	2004	2005	2006	2007	% Change, 2000-2007
Cambodia					1		1		-
Indonesia	11	13	9	13	11	12	7	9	-18.2
Malaysia	63	65	94	77	111	117	162	212	236.5
Philippines	17	22	30	45	39	26	44	33	94.1
Singapore	274	373	505	523	540	429	519	481	75.5
Thailand	***25***	***39***	***60***	***37***	***37***	***28***	***56***	***28***	***12.0***
Viet Nam	1	4		2	2	6	2	1	0.0
Total	1,318	1,644	1,833	1,884	1,970	1,755	2,427	2,282	73.1

Source: UNESCO Statistical Unit.

Table 2.4. Publications in English Language Scientific Journals, selected SEA countries, 1998-2008

Publication Year	Cambodia	Indonesia	Malaysia	Philippines	Singapore	*Thailand*	Vietnam
1998	8	305	658	263	2264	***855***	198
1999	12	354	830	292	2729	***965***	239
2000	14	395	761	334	3139	***1084***	298
2001	14	406	861	282	3397	***1235***	313
2002	22	377	883	378	3705	***1508***	319
2003	22	371	1029	369	4057	***1734***	372
2004	45	422	1194	384	4610	***1921***	392
2005	45	470	1389	416	5132	***2180***	503
2006	63	535	1609	411	5445	***2747***	551
2007	79	556	2037	467	5653	***3321***	677
2008	72	559	2325	483	5812	***3451***	707
National total	**396**	**4750**	**13576**	**4079**	**45943**	***21001***	**4569**
% growth 1998-2008	800.0	83.3	253.3	83.7	156.7	***303.6***	257.1

Source: Science Citation Index Expanded, 1998-2008.

Table 2.5. Scientific Papers by Selected SEA Countries and their Citation Rates, 1999-2009

Country	Papers *(n)*	Citations *(n)*	Citations per paper *(n)*
Cambodia	566	4,197	7.42
Indonesia	5,885	45,156	7.67
Malaysia	17,980	79,098	4.40
Philippines	5,370	44,295	8.25
Singapore	58,731	498,782	8.49
Thailand	***26,896***	***188,759***	***7.02***
Vietnam	5,878	41,043	6.98

Source: ISI Web of Knowledge, Essential Science Indicators, accessed 9 March 2010.

26. In Thailand, the number of R&D personnel relative to population size has grown very slowly. The total number of PhD graduates is less than 1200 in a population of 65 million with only 10% in engineering. The proportion of graduates in science and engineering to social sciences has actually decreased in recent years leading to skilled labor shortages. Around one million S&T graduates do not work in technology-related fields indicating a mismatch between the capabilities of graduates and market demands.

3. Innovation policy frameworks

27. Traditionally, science and technology policy in Thailand has focused on research and development based on the view that private firms are "users" of knowledge produced mainly by government agencies and universities. Although innovation was mentioned in several national plans, there was no articulated national innovation policy and innovative capabilities were not incorporated into the scope of S&T policies. Nor were S&T elements integrated into broader economic strategies or industrial, investment, trade and education policies.

28. Thai's industrial policy, which is under the responsibility of the Ministry of Finance, has dominated development with the goals of attracting foreign direct investment and promoting exports which tended to overshadow the need to develop indigenous technological capabilities. There were no explicit links between promoting foreign investment and upgrading the abilities of local firms. Trade policy has focused on reducing domestic demand for imports due to balance of payment deficits rather than on technology transfer.

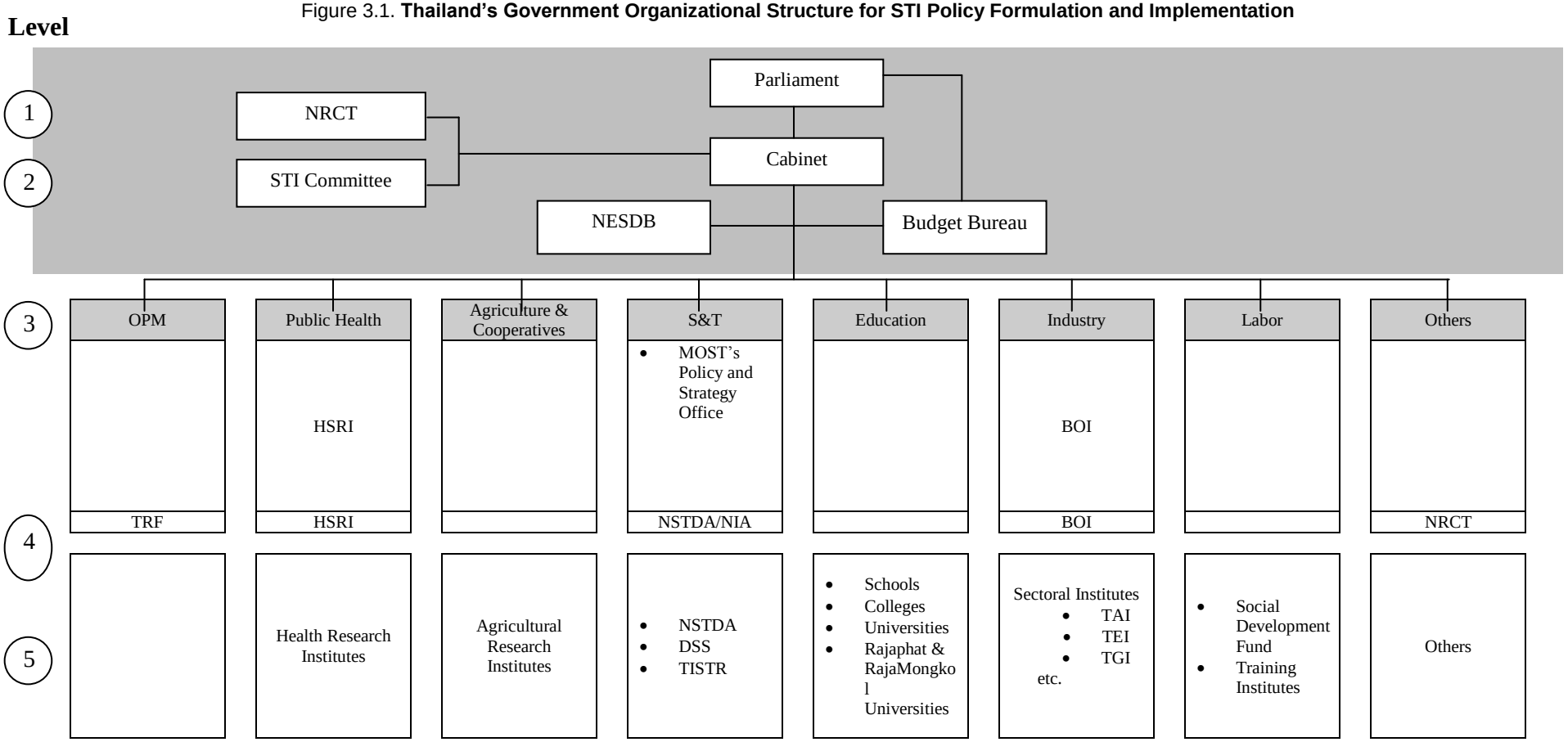
29. For many years, Thailand concentrated on infrastructure, general education, and exports, and there were no selective measures targeting the development of particular sectors. The exception was technological upgrading targets and local content requirements in the automobile industry which raised the local content of passenger vehicles to over 54% by 2008.

30. In 2001, a "dual track" policy was adopted to enhance the capabilities of Thai firms while increasing international competitiveness through strengthening the external side of the Thai economy, *i.e.* exports, foreign direct investment, and tourism. A National Competitiveness Committee was created to develop specific industrial clusters: automobiles, food, tourism, fashion, and software. The cluster concept became the main industrial and innovation policy at the national, regional and local levels. The National Economic and Social Development Board (NESDB) conducted a cluster mapping of the country to identify significant agglomerations of firms in various geographical locations. At the regional level, Thailand was divided into 19 geographical areas which were to implement cluster strategies focusing on a few strategic products or services.

31. The Board of Investment (BOI) extended investment packages for strategic clusters, such as hard disk drives and semiconductors, and gave incentives for Thai firms to participate in global value chains. Other government agencies supporting the cluster strategy included the Department of Industrial Promotion and sector-specific institutes under the Ministry of Industry such as the Thai Automotive Institute, Thailand Textile Institute, National Food Institute, and Electrical and Electronics Institute.

32. The ten-year Science and Technology Action Plan (2004-2014) enacted further measures to strengthen industrial clusters and their innovation capabilities. The National Science and Technology Innovation Policy Committee (NSTIC) and the National Research Council of Thailand (NRCT) coordinate the work of the core ministries in implementing this plan (Figure 3.1 and Table 3.1). In 2008, the National Science, Technology and Innovation Act was enacted with the purpose of strengthening S&T manpower and infrastructure. This Act is to be implemented by a new supra-ministerial structure, the National Science, Technology and Innovation Policy Committee chaired by the Prime Minister, which will monitor and report the results of the national STI Plan including the performance of government agencies.

Figure 3.1. **Thailand's Government Organizational Structure for STI Policy Formulation and Implementation**



Source: Updated from Bell (2003) and MOSTE (2003).

Table 3.1. **Functions of key STI policy making and implementation bodies in Thailand**

	Responsibility	Organisations
Level 1	National budget approval	*Parliament.* There are S&T Committees in both houses of the parliament. There is no special organisation giving advices to the parliament regarding STI policy.
Level 2	High-level cross-cutting policy formulation and development	*Cabinet*. At the lower layer, National Research Council of Thailand (NRCT) and National Science Technology and Innovation Policy Committee (STI Committee) are the cross-cutting policy formulation bodies for the areas of research and STI respectively. National Economic and Social Development Board (NESDB) is the most crucial governmental policy advisor and projects evaluator including S&T ones. Budget Bureau is responsible for budget allocation. These two agencies also play very significant roles in cross-cutting policy formulation process.
Level 3	Ministerial-level policy formulation	Apart from Ministry of Science and Technology, there are several other ministries involved in STI policies such as Ministry of Industry, Ministry of Agriculture and Cooperatives, Ministry of Labour and Social Welfare, Ministry of Education. Ministry of Public Health, and Office of the Prime Minister.
Level 4	STI funding and promotional incentives	There are several specialised agencies in several ministries. National Science and Technology Development Agency (NSTDA), Thailand Research Fund (TRF), and Health System Research Institute (HSRI) are funding agencies mostly for R&D activities. National Innovation Agency (NIA) is responsible for provide funding and interest-free loan for private firms' innovation projects. The Board of Investment (BOI) and Revenues Department provide tax incentives for R&D investment.
Level 5	Policy implementation	National Centres, governmental departments such as sectoral development institutes under Ministry of Industry, universities, and Research, Technology Organisations (RTOs).

33. The Ministry of Science and Technology (MOST) remains key to innovation efforts in Thailand particularly through the National Science and Technology Development Agency (NSTDA) which has overlapping and sometimes conflicting technical and funding responsibilities with the NRCT. To promote specific industrial clusters, NSTDA emphasis is placed on increasing R&D investments, enhancing private sector access to knowledge and information, promoting English as a second language, and upgrading S&T education and training.

34. The National Innovation Agency (NIA), formerly known as the Innovation Development Fund (IDF), provides financing in the form of grants and soft loans for innovative projects in firms primarily in the areas of bio-business, eco-industry, and design solutions. The NIA operates four financing schemes: 1) technology capitalization for testing prototypes, 2) "0 Interest Innovation Projects" to secure low-cost loans from banks for technology development, 3) cluster-based innovation projects primarily in biotechnology fields, and 4) venture capital to initiate production, although this last program has been discontinued. The NIA has also established an Innovation Management School which provides training for executives.

35. The government has extended R&D tax incentives at higher value if investments by companies in R&D or design amount to 1-2% of sales; if scientists or engineers with a bachelors degree comprise at least 5% of the workforce; if spending on employee training is at least 1% of the total payroll; or if similar amounts were spent on training the personnel of local suppliers. However, a survey showed that only 2-3% of firms knew about these fiscal incentives, which were often too narrowly defined for Thai firms to take advantage of them. Because of the complexity and rigidity of the system, only a handful of firms have availed themselves of R&D tax credits in recent years. Moreover, less than 4% of firms received grants for innovative investments from the Ministry of Science and Technology.

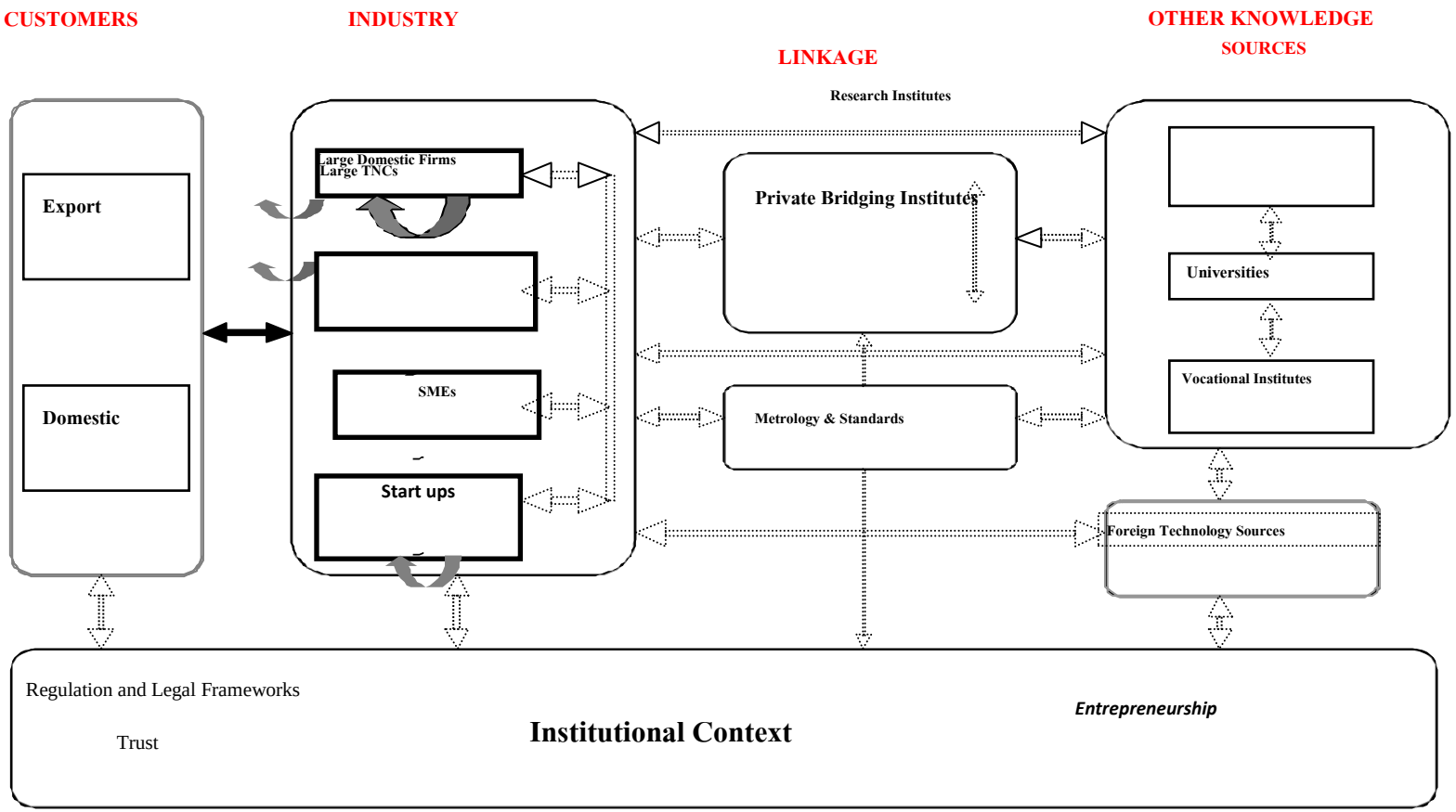
36. In 2009, the new government introduced a focus on making Thailand a creative economy based on the talent and unique culture of the Thai people. Emphasis is being placed on developing industries such as Thai food and cuisine, crafts, massage techniques and spas, films, and multimedia software. However, these efforts have thus far been unsuccessful due to the lack of linkages between creative industries and overall innovation programs.

37. Despite substantial policy efforts, industrial upgrading in Thailand has been limited due to the failure to coordinate agencies and policies and to disburse funds effectively. Projects tend to be captured by particular public interests and corruption has been widespread. Further improvements are needed, specifically in the institutional arrangements for the coordination of national science and technology policies and in fostering greater involvement of the private sector in policy formulation. In addition, fiscal incentives and grants for enterprises to engage in innovative activities need to be streamlined and better coordinated and implemented.

4. National innovation system

Figure 4.1 provides an illustration of Thailand's national innovation system, its main actors and the linkages between them.

Figure 4.1. Thailand's National Innovation System: Actors and Linkages



4.1. Business sector

38. Firms in Thailand tend to lag behind firms in other Southeast Asian countries in innovation performance whether they are multinational enterprises, state-owned enterprises, or SMEs. Only 12% of multinational companies in Thailand conduct research and development (R&D) which is a greater share than domestic firms. In 2008, the electrical machinery and electronics sector accounted for the highest proportion among R&D-performing firm (35%), followed by chemicals (16%), and R&D services (11%). Among multinationals, most R&D is performed by the electrical machinery sector including electronics (56%), followed by food, motor vehicles, and chemicals.

39. Surveys indicate that the most innovative Thai manufacturing sectors in terms of product and process initiatives are automobiles, wood products and food. The majority of Thai firms do not invest in R&D (Table 4.1), but rather in technological learning through acquisition of existing technology, reverse engineering, design, testing and quality control. Government efforts have generally done little to strengthen the innovative or absorptive capabilities of Thai suppliers as most firms do not avail themselves of government programs including R&D tax incentives, subsidies and grants, and technical and consulting services.

Table 4.1. Thailand's Innovation Surveys: Characteristics and Overall Results

	1999	2001	2003
Size of population			
- manufacturing sector	13,450	14,870	16,432
- service sector	n.a.	26,162	5,221
Total	**13,450**	**41,032**	**21,653**
Size of sample			
- manufacturing sector	2,166	3,945	4,850
- service sector	n.a.	2,137	1,181
Total	**2,166**	**6,082**	**6,031**
Response rate (%)			
- manufacturing sector	47.0%	36.7%	42.3%
- service sector	n.a.	37.3%	45.0%
Total	**47.0%**	**36.9%**	**42.8%**
R&D performing firms (%)			
- manufacturing sector	12.7%	4.4%	7.2%
- service sector	n.a.	0.2%	2.4%
Total	**12.7%**	**1.7%**	**6.0%**
Innovating firms (%)			
- manufacturing sector	12.9%	4.7%	6.4%
- service sector	n.a.	1.4%	4.0%
Total	**12.9%**	**2.6%**	**5.8%**

Source: Reports on R&D/Innovation Surveys Year 1999, 2001, 2003 by National Science and Technology Development Agency (NSTDA).

40. Although the products exported by Thailand have grown more sophisticated over time, the nature of the tasks performed in Thailand has remained relatively non-complex and low value-added, concentrating primarily on assembly manufacturing. Most Thai-owned firms, 23% of the first-tier suppliers in the automotive sector, manufacture labor-intensive parts and need to establish technical agreements or project-specific joint ventures with foreign suppliers to acquire technology. The research, design, development and branding of the export products of multinational enterprises are still done outside of Thailand. As value-added in manufacturing has increased, average wages and employment in the sector have stagnated with capital rather than labor inputs spurring productivity growth. Increases in the level of technology of export products reflect technology embodied in imported production equipment rather than indigenous efforts.

41. In addition to making small research investments in Thailand, multinationals have few links with indigenous firms. Transfer of technology is limited to the operational level as multinational companies tend to train their workers so that they can efficiently produce goods rather than equip them with design and engineering skills. MNEs have not been active in developing subcontractors or giving technical assistance to local suppliers. However, in recent years the MNEs have begun upgrading research and technological capabilities, particularly in electronics and automobiles, and have invested in efforts to boost the country's infrastructure and human resources for industrial needs.

42. Large MNEs in the automotive sector have begun to invest in more research and development in Thailand. Toyota Motor set up the Toyota Technical Centre Asia Pacific Thailand investing almost US$100 million in technical development facilities. The emphasis of the Centre is on materials development, vehicle testing for reliability, durability and comfort as well as design and engineering to fit regional needs. As Thailand improves its competitiveness in passenger cars, which have higher technological requirements than pickups, this may bring structural change in the innovation capabilities of indigenous firms. Within five years the eco-car segment is expected to account for up to 20% of automobile production in Thailand, providing opportunities for local assemblers and suppliers.

43. A small number of trade and industrial associations support the development of Thai firms including the Federation of Thai Industry (FTI) and the Thai Chamber of Commerce (TCC). However, members come primarily from commercial rather than industrial interests and their focus is on negotiating with the government on export quotas, import levies, and the tax regime rather than upgrading local innovation capabilities. Still, these associations provide some services including management consulting, standards certification, and training in energy saving and sanitary standards.

44. Although firms in the strategic clusters designated by the government are more open to change, co-operative consortiums among firms to research particular technologies or products are rare in Thailand. The intensity of relations between producers and users and between producers and suppliers is weak and customer-supplier links in Thailand are short and fragmented.

45. Recent innovation surveys indicate that many firms in Thailand engage in incremental innovation, particularly in introducing new products in the food processing, automotive and electronics industries. In 2010, the National Innovation Agency (NIA) initiated an "Open Innovation" activity bringing together 20 large Thai companies to discuss innovation problems and share knowledge to develop new products and services.

4.2. Higher Education Institutes

46. At present, there are 165 higher education institutes (HEIs) in Thailand of which 78 are public. Among the public HEIs, thirteen of them are autonomous in terms of less state control of activities, budget and human resource management. The leading universities are Thammasat University, Asian Institute of Technology, Bangkok University, Rangsit University, and Rajamongkol Thanyaburi. The persistent weakness in the quality of universities in Thailand, especially when it comes to R&D capacity, and the location of the leading institutions in a few urban areas has made it difficult for universities to serve as nuclei for technological clusters.

47. Limited interactions between universities and industry in Thailand have exacerbated skilled labor supply. Linkages between Thai universities and industry are mostly limited to consulting and technical services to augment the personal income of researchers. Most linkages are based on personal contacts and operate without an elaborate institutional framework. Firms generally do not regard university and public research institutes as important sources of information and knowledge. Industry has recommended that steps be taken to remedy the shortcomings of university graduates through a redesign of programs, reform

of curricula, revisions of textbooks, investment in laboratories and research centers, and more emphasis on practical skills.

48. University spin-off of start-ups firms is non-existent as larger local companies in traditional sectors are more likely to carry out joint activities with universities than SMEs. Firms which perform research in science-based sectors have more intense collaboration with local universities, particularly the petroleum, petrochemical, electrical machinery, telecommunications and computer sectors. In recent years, the Thai food processing industry is also using universities as a knowledge source and to improve production processes.

49. The Thai cabinet has approved a 15-year Tertiary Education Framework (2008-2022) focusing on knowledge and innovation including improvements in the collaboration of universities with industry and encouraging entrepreneurial endeavors from faculty to attract external funding. The establishment of the Thailand Advanced Institute of Science and Technology (THAIST) in 2009 is intended to promote collaboration between domestic research and educational institutions with overseas institutes for research and development, technology transfer and innovation, and S&T manpower development. The Office of Higher Education is setting up Technology Licensing Offices in public universities to spur commercialization.

50. The government is attempting to institute reforms to universities to include greater targeting of resources towards industry outreach. A successful case of university involvement in industry is the Centex Center of Excellence for Shrimp Molecular Biology and Biotechnology established at Mahidol University with support from the Thai National Center for Genetic Engineering and Biotechnology (BIOTEC). The aim of the center is to deepen scientific knowledge of shrimp and fish and find ways of preventing outbreaks of disease. The Shrimp Biotechnology Business Unit has been created to help commercialize R&D findings. Other promising cases of university-industry collaboration include the Petroleum and Petrochemical College at Chulalongkorn University which supplies skilled workers to the petrochemical industry in addition to providing testing and analysis services

4.3. Public Research Organizations

51. Public research organizations (PROs) in Thailand are regarded by firms as a less important knowledge source than universities. The National Science and Technology Development Agency (NSTDA) and the Thailand Institute of Scientific and Technological Research (TISTR) carry out basic research in wide-ranging areas. Institutes conducting technology-specific research include the National Synchrotron Research Laboratory, National Astronomical Research Institute of Thailand, Office of Atoms for Peace, and Geo-Informatics and Space Technology Development Agency. PROs conducting sector-specific activities include the Agricultural Research Development Agency (ARDA) which is advancing organic and bio-based production. Other institutes such as the National Institute of Metrology and the Department of Science Services are responsible for setting standards and providing technical testing services for companies.

52. The NSTDA employs 2 000 researchers in four national research centers which have fully-equipped laboratories: 1) the National Center for Genetic Engineering and Biotechnology (BIOTEC); 2) the National Metals and Material Technology Center (MTEC); 3) the National Nanotechnology Center (NANOTEC); and the National Electronics and Computer Technology Center (NECTEC). Activities are focused on research and development or providing technical services for public and private entities such as testing and calibrating. The PROs have few other links with private firms and generally do not assist companies in building capabilities such as technology assimilation, adaptation, design and engineering.

53. In recent years, industry has invested in strengthening local research institutes through cluster management organizations. The Hard Disk Drive Institute (HDDI) was created by IDEMA, an industrial association for hard disk drive firms, with local research institutes and representatives of key government organizations like the Board of Investment. The institute in engaging in research projects to upgrade the capabilities of the entire hard disk drive industry in Thailand.

4.4. Linkages

54. Limited collaborative links between universities, public research organizations and the business community have compounded the weaknesses of Thailand's innovative capacity. Because relational clustering is weak, few Thai firms are involved in the design phase of product development making it harder to acquire the skills and expertise that could lead to movement up the supply chain. Technological upgrading and product development which could serve as the springboard for relationships with MNEs and the emergence of dynamic industry clusters are hampered by the low quality of human capital and limited entrepreneurship in Thailand.

55. There are two important technology intermediaries in Thailand. The Thailand-Japan Technology Promotion Association (TPA) aims to diffuse knowledge and technologies associated with manufacturing, with over one-third of firms surveyed saying they have used TPA services. The Kenan Institute Asia (KI Asia) also provides a bridge for the exchange of knowledge, expertise, and information among government, universities and industry. One reason for limited linkages in the automotive sector is a lack of capable intermediaries as exist in the hard disk drive sector. The Thai Automotive Institute (TAI) has been entrusted to carry out such a role but it does not have the legal status of either a government department or an autonomous government agency nor a clear mandate as a promoter of industrial collaboration.

56. Thailand has invested in creating science and technology parks to encourage linkages between firms and other actors in the national innovation system. The Thailand Science Park has 60 companies in operation, of which 75% are Thai, together with the public research institutes BIOTEC, MTEC, NECTEC and NANOTEC. Plans are to increase the Thailand Science Park to 200 companies and 4000 knowledge workers. Software Park Thailand is home to more than 30 firms, mostly Thai, along with IBM, Hewlett Packard, Sun Microsystems, and Oracle. Training and certification are offered jointly by the NSTDA and Carnegie-Mellon University of the United States.

57. There are also several industrial parks with research capabilities including those in Navanakorn, Bangkadee, Rojana, and Bangpain. Firms in the parks receive a 200% tax credit for research and development expenditures and accelerated depreciation on research machinery and equipment. The Board of Investment grants firms work permit and visa facilitation for foreign specialists and researchers. In addition, BOI extends tax exemptions to companies for imported machinery, income tax exemptions for eight years, and 50% income tax reduction for five additional years.

5. Human resources

58. Inadequate human capital in Thailand represents another constraint to innovation. The major problem is an inability of educational institutes to produce enough S&T graduates with appropriate skills and quality that match private sector needs. Thailand does well on access to primary and secondary education, where enrollment rates are high. In 2009, the Ministry of Education launched a "Free Education with Quality" policy to reduce the financial burden of households and improve children's access to education. National expenditures on education and access to secondary and tertiary education are adequate and in line with regional peers. However, this does not appear to translate into outcomes. Thailand is lagging in math and science scores and innovates less than countries with comparable higher education ratings.

59. Thailand's 10-year Science and Technology Action Plan (2004-2014) aims to increase the number of Thais entering tertiary education and to attract 150,000 foreign students by 2015. In terms of bachelor degrees, Thailand has shortages of STI manpower in almost all areas, especially in the engineering disciplines. The proportion of graduates in natural sciences and engineering to social sciences is about 50%. The proportion of graduate students with master's degrees in science to that of social studies is about one-third. The lack of skilled workers is the top constraint to innovation identified by industry. More than half of firms indicate that the English language, information technology (IT), and numerical skills of their workers are poor.

60. Only a quarter of faculty members at Thai universities hold doctorate degrees which has hindered the expansion of research and development. Higher education institutes cannot catch up with technological change in the industrial sector as teaching remains academic rather than emphasizing creativity and self-learning abilities so that graduates can acquire knowledge and problem-solving skills. Very little of university curriculum has been developed through cooperation between industries and education institutes. In those few cases, the cooperation took place between education institutes and individual firms rather than industries as a whole.

61. For vocational manpower, shortages exist in certain areas, but the general assessment is one of over-supply. Since the late 1970s, the number of vocational students in Thailand had risen dramatically. But many of them remained unemployed, suggesting a disconnect between firm needs and the supply of human resources at this level (Table 5.1).

62. The Thai government has introduced various initiatives to improve the quality of the labor force. At the secondary education level, it has allowed privatization, encouraged integration of information technology and foreign languages in curricula, and adopted measures to upgrade teacher standards. However, instructional resources and teaching aids remain in short supply, and measures that decentralize authority to schools and raise the profile of vocational schools are needed.

63. A Science-Based Technology School (SBTS) has recently been established by the National Science and Technology Policy Committee and the Vocational Education Commission. The objective is to increase the number of the qualified vocational students by encouraging them to develop technical and creative abilities. Work-integrated learning is being expanded through the Practice Engineering School approach to meet industry demand for engineers. The program provides work and research experience at industrial sites to students who study for one year and work on industrial projects for the second year at the company.

64. Given the lack of innovation infrastructure, Thailand is losing its skilled workforce and worsening the problem of insufficient human resources for economic development. The "Reverse Brain Drain Project" initiated by the NSTDA in the 1990s to lure back Thai S&T professionals working abroad had limited success. Competition for knowledge workers is intensifying regionally and internationally, and Thailand lacks large national research projects or vibrant public research institutes which could provide financial incentives, professional challenges, and long-term career paths to encourage skilled nationals to return home. In addition, low private sector demand for innovation and upgrading does not create the conditions to attract the skills and knowledge of the Thai Diaspora. In order to draw foreign skilled labor, Thailand recently increased the length of visas for researchers and technology workers from two years to four years.

Table 5.1. Gap of Knowledge and Skills of Human Resources between Industry's Demand and Education Institutes' Supply

Industries	Gap	Education Institutes
Using specific and sophisticated technology and more interdisciplinary knowledge needed	Lacking knowledge and technology information with real-life practical lessons	Using obsolete technology. Too departmentalized knowledge
Little participation in curriculum development	Lacking mechanism in integrating academic curriculum with demands from industries	Developing curriculum based on what instructors believe appropriate
Emphasis on analytical skills in problem solving	Lacking methodology in cultivating students to be self-learners	Emphasis on theoretical lessons and examinations more than self-learning
Need knowledge and working skills such as basic statistics and quality management	Those essential knowledge are not addressed as prerequisite or required courses	Statistics and quality management are selective courses; few students choose to study
Need literacy skills, such as English communication , computer programming skills for managing work processes	Lacking important skills especially for today's globalization economy, such as skills in international-language communication and computer management	Some courses like English are compulsory courses but not considered by students as important courses. Some courses (e.g. computer) are not available.

Source: College of Management (2003).

REFERENCES

Intarakumnerd, Patarapong (2010), "Country Profile of Thailand for OECD Review of Innovation in South-East Asia," College of Innovation, Thammasat University, Thailand.

OECD (2010), "Review of SME and Entrepreneurship Issues and Policies in Thailand at National and Local Levels", Centre for Entrepreneurship, SMEs and Local Development.

World Bank (2007), "Towards a Knowledge Economy in Thailand," Washington D.C.

World Bank (2010), "Thailand Economic Monitor," Washington D.C.

World Bank (2010), "Thailand: Towards a Competitive Higher Education System in a Global Economy," Washington D.C.